On Two New and Undescribed Methods of Contractility Manifested by Filaments of Protoplasm.—PROF. J. A. RYDER presented the results of his recent investigations of the peculiar phenomena of contractility presented by the stalk of *Vorticella* and of the body of *Trypanosoma balbiani*. The speaker pointed out that all the accounts of the mode of contraction of the stalk of *Vorticella* hitherto offered were either inadequate to account for the facts or else wholly inaccurate. No figures yet published give a correct picture of the relations of the muscular filament in a spiral, and the outer tubular sheath which invests that muscular filament. Neither has there been any correct account given of the way in which the spiral condition of the stalk of *Vorticella* is generated as a consequence of the contraction of the muscular filament.

The true state of affairs is as follows:—The muscular filament of *Vorticella* passes downward through its sheath in a spiral manner and is only in contact along a spiral line with the inside of the transparent investing sheath. The filament thus makes eight or nine complete turns within its sheath which is itself not in contact with the spiral muscular filament except along the spiral line already mentioned. It follows from this, that if this spiral line of contact is in turn traced upon the muscular filament, it will be found to describe a spiral around the latter.

In a condition of contraction it will be found that the inner faces of the spirally coiled muscular filament are in a state of greater compression than the outer ones and that therefore the inner side of the muscular filament has suffered a greater contraction of its substance than the outer. This face of the filament again is found to correspond to the face which is in spiral contact with the sheath in the uncontracted condition. But to fully satisfy the mechanical conditions of the problem, it is necessary to assume that the contractile filament of *Vorticella* is composed, as are ordinary striated muscular fibers in higher forms, of alternating and superposed disks of singly and doubly refractive plasma, or at least of a series of disks whose most contractile margins are permanently arranged in conformity with the spiral line which can be traced along the surface of the filament where it is in contact with the investing sheath. In this way alone is it possible to account for the way in which the spiral coil in the contractile stalk of *Vorticella* is generated. In this way only can it be supposed that a muscular fibre may contract at a uniform rate so as to bend continuously and constantly in two directions so as to generate a spiral in accordance with the well-known laws which preside over the generation of uniformly coiled spirals in space. After this conclusion had been deduced from an attempt at a diagrammatic construction of the spiral stalk and analysis of its components, observation of mounted preparations of *Carchesium polypinum* showed that the coiled parts of the muscular filament are actually composed of discoidal elements such as are met with in ordinary muscular fibre alternating apparently as sin-

gly and doubly refractive elements. Further study disclosed the remarkable fact that the disks of anisotropic matter are in contact along the concave or inner side of the coils and not in contact on the outer or convex sides or faces of the coils, where a wedge-shaped mass of isotropic material seems to be interposed between the outer edge of the successive anisotropic disks. This is, in fact, the condition which should have existed, *per hypothesis.*

The torsion into a spiral of the muscular stalk of *Vorticella* may have been due to the constant torsional strain of the crown of cilia vibrating constantly in a cyclical manner in one direction setting up a vortex movement, such a vortex tending constantly to maintain the torsional strain and thus add the additional spirals or twists to the new parts of the muscular stalk as the latter is lengthened by growth next to the animalcules' body. This hypothesis of torsion the speaker had not yet verified, but he had no doubt that the facts when ascertained would countenance it.

The development of a progressive spiral in either direction may be caused by rotating the wave of contraction around the center of each one of the successive disks of contractile matter, here hypothetically assumed and actually found to exist in some forms of *Vorticella.* This is of great importance in acquiring a comprehension of the generation of the spiral in *Trypanosoma balbiani,* the parasite of the alimentary canal of the oyster, as well as in the case of many spiral *Schizomycetes* and long flagella, many of which have spiral rather than a simple undulatory movement. If the contraction wave for each successive disk is a little behind or a little ahead of its next neighbor, or, what amounts to the same thing, if the revolution of these contraction waves follows a spiral line turning to the right or left, then will the spiral be generated in a sinistral or dextral manner so as to determine the direction of movement either forwards or backwards or alternately as happens in *Trypanosoma balbiani,* in which the revolutions of the organism so caused, occur with the greatest velocity. In this connection it is interesting to mention the extraordinary behavior of a string of gyrostats when set rotating in a connected series suspended one to the other. If they then be disturbed there will be generated a curious progressive cork-screw motion which will travel along the series, as pointed out by Sir William Thomson, or, as suggested to the speaker by his colleague, Prof. G. F. Barker, the analogies with some of the phenomena of the polarization of light are also interesting.

In conclusion, the speaker insisted that the type of muscular contractility presented by the muscular filament of *Vorticella* had no analogue amongst the muscular elements of higher animals, and it, therefore, constituted a type by itself, where unequally contracting disks were fixed in a spiral order.

The second form was typified by the filamentous *Trypanosoma balbiani* in which there is a rapid reversal of the spiral in a dextral

or a sinistral direction and in which the contractile disks (here hypothetical) are not fixed but in which waves of contraction may be supposed to revolve, as described above, either in a sinistral or dextral direction, in order to continuously maintain the spiral condition, and also at the same time cause the spiral to apparently travel from one end of a filamentous organism or flagellum to the other. Two very distinct and constant types of filamentous muscular or plasmic contractility the speaker believed might be thus characterized with *Vorticella* and *Trypanosoma* as their types, in addition to the single ordinary form presented by the usual types of smooth and transversely striated muscular fibres.

The following was ordered to be printed:—